No. 20

MECHANICAL INK MARKS

A STUDY OF MECHANOGRAMS AS MEANS OF IDENTIFYING MARKS MADE BY MECHANICAL APPLIANCES, AND DETECTING IMITATIONS THEREOF

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THE MARKSMAN

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For many years I have made a specialty of scientifically examining and testing questioned documents of all kinds, and assisting in the determination of inquiries concerning same, either as Special Counsel, or Expert Witness, or Consulting Specialist.

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Copies of this Booklet may be procured from the Author.

Mechanical Ink Marks.

"Ask why God made the gem so small,
And why so huge the granite?
Because God meant mankind should set
The higher value on it."

The scientific examination of questioned documents shows the truth of the above lines. It is the small things that should be given the greater weight; for we may safely assume that the larger ones have already been noticed, and taken advantage of, by him who would deceive.

GRAMMIC METHODS IN GENERAL.

For many years the Author has been seeking the "gems" and especially investigating and testing the values, for purposes of identification, &c., of characteristics in written marks that can only be seen when highly magnified. Such features are incapable of being copied into a natural sized "duplicate" mark; they are inimitable by any other creative agency, and cannot be excluded or concealed, by the agency which gave them their existence.

Such investigation is based upon the manner in which the ink or marking material is deposited upon, and distributed over, the surface of the paper, &c., covered by the mark; this is to be viewed at a magnification of from 75 to 100 diameters, the precise enlargement depending on the nature of the mark to be examined.

DYNAMOGRAMS AND MECHANOGRAMS.

The results, so far as they concern handwriting, have heretofore been published by the author in his "Questioned Ink Marks" and elsewhere, under the head of Dynamograms. He has also published the results of a consideration of a mixed type of marks produced by the carbon paper and telautographic processes,—the combined effects of mechanical and human efforts. But the present is the first publication in regard to purely mechanically produced marks, where the human hand is not a direct

factor; in this connection, the enlarged image of the mark is known as a Mechanogram.

The difference between the terms "dynamogram" and "mechanogram" is simply descriptive of the different manners of their production; the one is due to the dynamic forces of the human body, while the other is caused by the mechanical force of some appliance. In both we consider the outlines of the mark, observing (a) the general pictorial effect of the whole, i. e., its character, and (b) the numbers of separate and independent irregularities recorded along the margins, i. e., its serrations and indentations. In dynamograms of pencil marks, and in mechanograms, it is important to also observe (c) the body of the mark, i. e., its surface; and in mechanograms we must further look to (d) the space outside of, and surrounding, the mark itself, i. e., the outer field.

MECHANOGRAMS.

It must be noted that mechanograms of marks where the ink is simply *flowed* on the bed surface by a *stylus-like point* (as in the various types of recording registers) are not included in the scope of this paper, but are reserved for later consideration. *Solid* ink marks (as of carbon paper) are also excluded.

In the analytic examination of a mechanogram along the lines mentioned, the observer will gain much information regarding the "body" and action of the ink used; this should be supplemented by a cursory examination at very low power magnification—not over 5 or 6 diameters. Such data is important because it distinguishes the *condition* of the ink of the mark, and every distinct process requires ink specially adapted to it in certain respects. The ink may be thick or thin, in its consistency; it may be oily or watery in its mixture; and its coloring material may be in true solution or merely consist of finely divided particles held in suspension. The many other ink qualities are unimportant to this investigation, and, at any rate, have been elsewhere treated, by the Author.

The analytic observer will also be informed from the mechanogram concerning the force applied, and the manner of its application, in producing the contact between the inking and receiving surfaces. Here again a supplemental examination at very low power will sometimes assist, by covering a larger field at one time, in the observation of very gross features. The force

applied may be little or great; it may be like a hammer blow, or merely a pressure, or both combined. The contact may be made directly or through some intervening medium such as a stencil or cloth; it may be made by small individual units, acting separately, or by a combination of many of them acting together; it may be made with much or little ink; and the cloth (if there be one) may be stationary or moving.

Then, with regard to the appliance used, the mechanogram will give the analyst the birthmarks and scar marks by which to differentiate and identify the particular appliance; and further,—if the marking surface have been made by human hands, there will generally be sufficient earmarks about it to identify it as the work of those particular human hands and to distinguish it from others. In this connection, it is usually advisable to supplement the high power examination with one of medium power, (the more readily to obtain shapes and sizes of *entire* characters,) and with a low power magnification (to gather together the *larger* imperfections in a more extended field.)

In *all* of the branches of such examination, it is essential to use the high power enlargement, and *none other is absolutely necessary;* but, because the use of lower powers is always more convenient, the supplementary use of the lower powers is recommended for such *coarser* work as can be thereby accomplished. It must be borne in mind, too, that this is a study of *mechanograms,* and does not pretend to cover the older and cruder methods—where they exist—of examining and testing such marks; there are some such latter methods in use as to a small part of the appliances hereinafter referred to, but only a very few of them have any scientific foundation, and consequent weight.

CLASSIFICATION OF MARKS.

It is impossible to make any general classification of the marks under review that will altogether avoid repetition, as many distinctly different appliances are operated partly or wholly on similar mechanical principles;—least of all, can we take up the appliances separately. The least objectionable method is to consider first the mechanical factors themselves, and then to bunch the processes according to their broad general characters.

So, first, as to the mechanical factors and their respective effects:—

A.—SURFACE MARKED.

This is usually paper. Generally, the mark will be somewhat affected by the character of the surface as to its hardness, absorbent quality, and roughness, but the extent and nature of that effect will depend entirely upon the combination of the other factors. Its character is readily ascertainable, and due allowance can be made for it without interfering with the rest of the work.

B.—THE INKING.

The ink may be used in combination with a gelatinous carrier, as in marks of the hektograph general type; the mixing will cause a tendency for the outlines to shade off, and thus to become cloudy and ill defined.

If the ink be of an oily nature, and there be an excess of oil in it when used, as when it is not sufficiently mixed at the time, there will be more or less of a separation of the oil after the mark has been made, the solids remaining fixed, but the liquid being carried, by capillary attraction, into the surrounding outside space. This will cause an appearance of shadowy outline, or corona, outside of and beyond the normal colored field of the mark. Such a condition is often observable (even by the naked eyes) in work of various duplicating processes of the mimeograph general type; and of many metal stamps.

The thinner the ink body be,—with a given kind and amount of force used in its application,—the greater will be the distance to which it will be forced out beyond the edge of the marker, and it will be splashed out in the form of a long narrow "shoot." As the body thickens up, the length of the shoot will lessen, and it will change into a wider form, first becoming a short, blunt projection, and then a large headed "mushroom" shaped body. The harder and more sudden the impact—with ink of similar body—the greater the tendency to longer projections. The reason for these phenomena is, that practically in every case where a mark appears "properly" inked, there is in fact more ink used than is necessary, and the excess is forced out from between the marking, and marked, surfaces, in the manner indicated.

The marks may be lacking in definition simply because of the color of the ink used. Black and red shades are the least

subject to this colorimetric distortion, while blue is usually as unsatisfactory as the very light tints, owing to the coloring materials now generally used.

The inking may be done by the surface to be marked being brought in direct contact with the surface of a pool of liquid ink, and thus picking up as much as will cling to it, as in the general engraving type of work. This is calculated to produce a "lake" surface on the mark itself, as if heavy bodied ink were *flowed* over it, and left to dry. In all the other cases under consideration (except in hektographic processes) the mark surface will be either non-flowing, or else actually more or less seedy, depending primarily on the thickness of the ink, and secondarily on the force of the impact.

A pad may form the source supply, as with ordinary hand-stamps. In such event the ink may be of an oily nature—as to which see *ante*—or it may be of hygroscopic character. The former variety needs to be re-inked occasionally, while the latter kind takes care of itself by absorbing moisture from the atmosphere. Hence, when the air is humid, the latter pad gives off a thin watery supply of ink, which slightly lessens at other times. As to the effect of *thin* ink, see *ante;* in addition, owing to the *hygroscopic* nature of the ink itself, and its being thinner when the atmosphere *at the time of its use* is unusually full of moisture, the ink will be *slow to dry* after the mark has been made, and this will render it likely to be disturbed by extraneous means of soiling. Consequently, such distortion (which is plain to observe) must not be ascribed to another cause. Then again, the pad may be of the hektograph variety—as to which see *ante.*

Very often—but only within comparatively recent years—the inking will be found done by a cloth ribbon of fine even texture, which has been thoroughly saturated, and its interstices filled, with semi-solid ink. This ribbon is closely woven with the threads at right angles, so that its surface is really much like a very fine sieve, having cavities between double-thick points where the threads are crossed; and this barred network of threads is calculated to produce a typical effect. The ink on the ribbon must necessarily be of very thick body—semi-solid—usually producing a sort of latticed effect on the entire mark, unless the pressure be extremely heavy and the ribbon extremely full of ink; even in these extreme cases, the "lattice"

points will be more or less distinct on the sides of the mark. Thus the texture and mesh of the ribbon can be ascertained; in which connection it may be stated that in typewriter ribbons, the threads across the ribbon generally run from about 120 to about 150 to the inch; it must also be remembered that the threads cross each other practically at right angles, but that they are not always actually of exactly the same thickness. All of these features are found reflected in the mark. Then too, with the use of a ribbon, there is always a probability of the *outer field* of the mark—the space beyond it—being more or less soiled by specks from accidental contact with the ribbon.

Then, too, when a ribbon or cloth is used as above, different effects will be produced by the frequency of the ribbon-shift. In appliances such as some metal stamps, the ribbon is left in one position for a long time, until its ink is pretty well used up, or until there is some necessity to change some of the characters on the face of the stamp; here the threads of the ribbon will retain the same relative positions on the faces of given characters, until the delayed shifting comes along. In some of the duplicating processes, however, the ribbon is shifted after every impression; in such case the ribbon threads will retain a similar relative position throughout the entire impression, covering all the various characters used in that impression. Then in such processes as ordinary typewriting, the ribbon is shifted after every individual character is used; therefore different imprints of the same character are likely to show variances in the relative positions of the ribbon threads, in even a single contemporaneously written sheet.

C.—THE MARKING.

The marking may be *direct,* as where the marking form (after being duly inked) is brought into immediate contact with the receiving surface. This will produce a distinctive effect, depending on the process and ink.

Again the marking may be *indirect,* as where a cloth or stencil intervenes between the inking surface and the receiving surface. As before, another distinctive effect will follow, which will be varied by the process and ink, but which generally will result in more irregular outlines, in their entireties.

The marking form may consist of single, loose, separate units, or of a number of units combined into one fixed form. In the latter case there will be more general uniformity in entire impressions, but more variation in the impressions of similar single characters. In the former case these conditions will be practically reversed (on the whole) because of the repeated use of the same identical form, instead of the combined use of a number of similar forms, and because of more frequent variations in the force of contact.

The marker may be of a "cameo" type of cut or mold (as in ordinary printing and typewriting) with the marking characters standing *in bold relief,* on a depressed field; or they may be just the reverse of this—of an "intaglio" type—when the forms of the characters will be cut *deeply* into the surrounding field, and where the mark is made by the *field* and *not by the sunken character.* In the former case, speaking generally, there will be distinctively better definition of the marks and less irregular outlines than in the latter case, depending on the force of contact, and the process and ink used. Certain steel die stamping is, however, an exception to this general rule, but such work has a distinct individuality of its own.

Often the marker will present an *almost flat* surface, as in processes of the general character of lithographing, which produce a remarkable and distinctive roughness in the outlines of the marks so made; such marks differ from those of the other mechanical processes, and where lithographed from stone, the mechanograms (in many particulars) resemble dynamograms of actual handwriting. Another *almost flat* surface is in stencil work, which shows its own peculiarities, whether a clear cut stencil be used (as in certain addressing machines) or only a partially cut one be employed (as in many of the duplicating processes); as between the two kinds, of course, that which is clear cut will produce clearer and less ragged impressions than the other. In all stencil work the variations are principally in *reduction* of a maximum width of line, while in other work the variations are usually rather *extensions* of a given minimum width.

Finally, the marker may be *entirely flat,* as in processes embodying the hektograph principle. Here the marking consists in the transfer of a thin layer of the entire jelly-like pad—both marked and unmarked portions—to the receiving surface, pro-

ducing its own distinctive effect on the entire receiving surface, as well as on the portion just within the lines of the ink mark. As to the ink effect here, see *ante*.

D.—THE CONTACT.

The force exerted in producing the contact of the two surfaces—marking and marked—may vary anywhere from very light to very heavy; if very light, the inking will be more fragmentary, unless the marker be made of very soft material; if very heavy, the opposite condition will generally exist, and often (except in certain processes such as die stamping, &c.,) there will be a marked tendency for the ink to be shot out sideways to considerable distances.

In processes like hand-stamping, typewriting, &c., where the work is done more or less on the single unit plan, the force exerted will vary from character to character, depending upon the peculiar action of the motive power; this irregular degree of strength will leave its impress on the mechanograms. And where the mechanism is operated from a *keyboard,* the *touch* of a given operator will likely be similar on characters located in the same position on the keyboard. Where there is less of the unital application of the force—where numbers of characters are done at once—as in ordinary printing, for example, the force will be applied much more regularly and evenly, and we will find such history of its work when we come to examine the mechanograms.

E.—THE FORCE APPLIED.

The force bringing the marking and marked surfaces together may be exerted merely in the form of *pressure,* as in many of the duplicating processes, as well as in adding machines, cash registers, engraving, lithographing, and in most printing presses, &c. Such application of force results in a gradual greater or less *squeeze,* which forces the ink out on the sides in manners distinctive of the particular processes, and varying greatly according to the pressure exerted.

Then the contact may be made by a sort of hammer blow, where considerable force is *suddenly applied,* as in case of ordinary typewriting, and also of some stamps. Here the suddenness of the blow will tend to force the ink out sidewise to considerable distances, depending on the consistency of the ink. Therefore, by this means, the roughness of the lines is likely to be much exaggerated.

An in-between effect, leaning more towards the first application of force, is found in processes which *combine* the squeeze and blow by *suddenly and greatly* increasing the pressure; this occurs in some few forms of duplicating apparatus, stamps, printing, and addressors.

F.—MATERIAL OF MARKER.

A marker made of any yielding substance—rubber, for instance—will of course be more affected by pressure than if the material were not pliable; consequently, the size, shape, and proportions of a character so made, will often vary in different impressions of the same identical marker; even the mechanograms will be more or less affected by such conditions. This peculiarity will be less frequently found in work of the soft hektograph-pad type, because there both blank surface and mark are transferred; but here there is more likelihood of air bubbles, and of freakish distortions of the characters.

Hard materials—wood, metal, or stone—being unyielding, are quite fixed in the above features, and variations in their marks can only come from extraneous causes, such as differences in pressure or ink or in surface to be marked. The hard materials are capable of having great force applied if desired, and can be given smoother faces and edges than the others, all of which factors tend to make them capable of marks having greater general regularity, better defined lines, and more complete and accurate contact; but this possibility cannot be realized if accompanied by a hammer-blow motive force, as that would necessarily shoot the ink out wildly far beyond the edges of the marker.

If a stencil of any kind be used, the inking must be done *through* the thickness of the stencil cuts, and is bound to be quite rough in its own peculiar way, according to the character of the stencil; the ink must be forced through the stencil by either a hard or soft instrument, and this condition will result in more or less variation in sizes, &c., of the mark, below the given maximum size, &c., of the actual stencil.

G.—FORM OF MARKER.

Considerable variations in results are caused by differences in the forms of the marking appliances, even when the appliances are supposedly in perfect condition and adjustment. From

that time on, additional variances will be constantly cropping out, wear and tear, accidents and other causes uniting to produce ever-increasing imperfections. Thus, not only will the different processes be distinguishable, but the separate single instrumentalities will be always acquiring more and more individuality.

In gelatine pad processes, and the like, more or less of the entire surface is removed with every use; owing to the method of producing contact, the contact is rarely even all over, thus causing the surface to wear away more or less unevenly, and increasing the chances of uneven contact the next time it is used. The irregular contact may occur either in the setting of the original text, or in taking off the copies, or in both. In all cases it will speak for itself in these particulars.

Where stencils are used, they are rarely perfect in their own outlines; then they are often liable to slight fluctuations of position; characters produced in the stencil by the same identical master die may not be exactly alike in the stencil, and may be less so in impressions from that stencil; as the ink must be forced through the stencil cuts, a great deal will depend on how, and with what force, this is done. These variations will all write their own tales in the marks.

In ordinary stamping processes, where there is no rigid frame to guide the stamp in its contact, it is seldom that the stamp will be brought down squarely and evenly in all its parts, and unless the contact be made absolutely uniformly all over, distortion and unevenness will follow. Whether so guided or not, it is pretty certain that the force applied will vary in different impressions, if human hands be the direct motive power. Whenever part of a stamp is *changeable,* that condition will give rise to a number of possible—yes, probable—decidedly individual variations, due to the condition, form, material, and placing, of the changeable characters.

Whenever the form of marker is a *type bar,* the most delicate adjustment is required, and while this is done with considerable accuracy in the manufacture of the machine, yet there probably never was an absolutely perfect machine in this regard; some slight inaccuracies will generally exist at the start, but even if such be not the case, the entire mechanism readily lends itself to the creation of such inaccuracies by the use of the apparatus; accidents and even usage will also produce imperfections in the types, outside of the adjustment. The mere necessity for the

free play of the type bar is a guarantee of freedom amounting to variation in that play, affecting both the power used and the form and position of the mark. It must be remembered always, that the actual types are usually *interchangeable,* and may be used on different machines at different times.

If a *type wheel,* or sleeve, be substituted for the typebars, then other distinctive traits appear, because here the types are all in one solid casting, which is moved around to select the desired character; thus whatever affects the motion of one letter, likewise affects them all. The pressure will vary as before, and other working parts may likewise vary, but the types are *united.* There may be a *series* of type-wheels used at the same time on the same machine, as in certain adding and numbering machines, in which case, every single wheel is to be considered *separately,* in the foregoing particulars; afterwards the different wheels should be compared with each other. Again, the wheels may take the form of united flexible strips bearing the types, as in many daters, &c., in which case, what is said above applies, but reference should also be made to the remarks regarding stamps—particularly such as are made of rubber. In all cases, some variation will appear according to whether the *type-wheel gives* or *receives* the blow in producing the contact. Here again, it must be remembered that type-wheels, &c., are interchangeable.

The use of a lever as the motive force (as in certain adding machines and cash registers) is generally concurrent with an even contact and with a more nearly even pressure in that contact, than in most other cases. The same applies where a wheel takes the place of a lever, as in some cancelling stamps and printing presses.

Where the use of suitable cams, &c., causes a *suddenly and greatly* increased pressure as soon as the surfaces have come easily together, there is a combination of pressure and hammer blow effects, as to which sufficient has already been said.

Where the work is done by a plate, as in ordinary engraving processes, there is a necessity for an excessive degree of force in pressing the surfaces together, but it will be evenly distributed over the entire field covered by the characters and then be shaded off gradually in all directions so as to cause an even impression of all the characters, and a barely noticeable variation beyond their field. The softer the metal of the plate, and the more pliable it is, the more prominently will the ink be forced out beyond

the edges of the character and the rougher will be the outlines of the mark. Hence a copper plate will produce rougher lines than a steel plate.

Where a die is used instead of a plate, it being hard, stiff and unyielding, though generally of smaller surface extent than a plate, exceedingly great pressure is required, and will be exerted evenly over the whole surface; the pressure will be very noticeable because not shaded off away from the characters, but stopping rather abruptly at the edge of the die; the ink will be more confined within the bounds of the character, producing relatively even, smooth and distinct lines. Both die work and plate work will usually have the marks more or less raised above the surrounding field surface.

In stone work, such as lithographing, there need be less pressure, but it will be evenly exerted, and as here the ink for the mark is resting on a comparatively flat surface, the receiving surface will not be visibly affected by the marking surface, as a whole, and there will be very much spreading of ink to a short distance beyond the edges of the mark, leaving the same with a rough outline bearing a remarkably close resemblance to hand-written marks produced by the person who actually prepared the original design on the stone. The reason is plain:—The design on the stone is (in these particulars) really handwriting, done by its designer in the ordinary way, but by the use of slightly different materials.

We come now to the second division of our classification, viz.—the general bunching of the various *processes* under consideration—about sixty in all—most of which cover quite a number of different makes and designs of machines, as, for instance, typewriting and duplicating. Let us begin with—

A.—STAMPING.

1. *Pad work* (Rubber stamp)—Gives non-flowing, splashing type of line, varying in different parts of same impression; also (in actual size, shape and sides) in same part of same impression, according to force of impact. One general character of line maintained throughout stamp. Lines rougher than two-point handwriting, increasing with force of blow; generally less "wild" than single-point ink handwriting. Sides of lines usually continuous, sometimes ill-defined; frazzled and with "wild" shoots and slashes. Indentations prominent; serrations variable

in numbers, keeping to general range, but no fixed relation between the sides. Results considerably affected by ink and by paper surface.

(Wooden stamp)—Substantially same, *except:* Less variation in actual size and shape of marks; sides generally well defined, but with greater tendency to "wild" shoots; character of line and range of serrations more variable.

(Metal Stamp)—Lines non-flowing as to *body* of color, but often with corona. Sides generally indistinct, wild and much frazzled, but without the "shooting" quality. Like wood, as to actual size and shape, but like rubber in maintaining general character of line, and in relationship of serrations, but fewer serrations, on the whole. Generally uses different ink from previous stamps. Lines generally rougher than two-point, and about equal to one-point, ink handwriting.

2. *Fixed-ribbon work* (Metal stamp)—Considerable similarity in impressions till ribbon, or part of stamp, is changed, but impressions varied slightly by paper surface. Outer field often soiled by ribbon specks. Lines non-flowing, without the juicy "shoots," for which "mushroom heads" are substituted. Outlines deeply indented, very rough, non-continuous, frazzled, and ill-defined. Wide variations in actual outlines, but not in general character and sizes. Ribbon threads cause fixed "latticed" effect, with opposite humps, of considerable uniformity in contemporaneous combinations. Sides of lines rarely agree in details, because of fixed relative positions of ribbon threads and type faces. Light blow causes only rows of spots representing thread crossings, but heavy blow will close these up; other variations of force have little effect on mark. Lines less erratic than printed imitations of ribbon typewriting.

B.—TYPEWRITING.

Under this head are included not only the popularly termed typewriters, but also bed-plate billing machines, cash registers, and adding machines.

1. *Pad inked* (Type-bar or type-wheel with keyboard contact)—Lines non-flowing, but not broken or seedy unless ink pad dried out; somewhat resemble metal-pad stamp used with hard blow. Impressions rather cloudy and indistinct, without long "shoots" or mushrooms, but often having short blunt projections

like hammer heads. No soiling of outer field by specks. General shapes and *widths* of lines close, but no symmetric swellings of the lines. Sides of lines more irregular, and deeper cut, than in two-point handwriting, and they vary in character, and in actual and relative numbers of serrations; these features are retained in different impressions as the types are set or "framed" in their positions. *Range* of serration numbers about like metal-pad stamps.

(Separate type-wheels with lever contact)—Every separate wheel has its own characteristics. Lines often indistinct. Impressions subject to rules of "framed" types, and general character of all types of about same size, is close. General contours much more regular than pad stamps, or other pad typewriters, and without shoots, mushrooms, or corona—the contact being a *squeeze,* instead of a *blow.* Serration numbers variable and without any relation between the sides, but range of numbers about like metal-pad stamps.

2. *Movable ribbon* (Type-bars with keyboard contact)—Mark affected by force of blow—i. e. "touch." *Particular type* retains general *character* of mark and proportions, imperfections, and position of face, especially where same ribbon used; but character less constant than in *fixed* ribbon marks. Different impressions of same type may vary greatly in *width* of lines. Lines very frazzled and seedy, often non-continuous and with outer field soiled by specks. Outlines "wild" and irregular, often with mushroom heads. Ribbon mesh usually indistinct; irregular and unsymmetric swellings on sides of lines, tending to establish coarse relation between the sides. Many serrations (where calculable) but no relation between sides as to them.

(Type-wheels with keyboard contact)—Stroke generally lighter than with type-bars, wherefore ribbon mesh plainer and swellings of lines more symmetric; more affected by paper surface; less soiling of outer field. Outlines and widths of same line vary much in different impressions. Edges much frayed and lines tend to have "air holes" in their surfaces. Side cuts vary in numbers and in some machines the two sides are nearly even, in numbers. *Character* in different machine marks close, but distinguishable by actual numbers, and relation, of cuts in edges, and by ribbon mesh.

(Bed-plate writers, with type-bars and keyboard contact)—Much like regular movable ribbon type-bar typewriters, ***except***

there is less tendency to variance in and between the two sides, and to soil the outer field. Edges seedy and much frazzled, with mushroom heads. Widths and contours of lines vary, but general character retained.

(Separate type-wheels, with lever contact)—Different impressions agree in general shape and size but not in width of lines or actual contour; less variation in widths than in typewriter where but single character written at once. Lines frazzled and seedy, with prominent indentations, and often non-continuous, and showing mushroom and hammer heads. Swellings of line wild, irregular and poorly marked, but showing relationship between the sides. Outer field sometimes soiled with specks. Serrations vary greatly and show no relationship, yet general *character* alike for every machine, and every *separate wheel* has its own characteristics.

C.—DUPLICATING.

Under this head is included the ordinary duplicators, and also the various addressing machines.

1. *Gelatine pad machines.* (Typewriting)—Size shape and imperfections of original type shown, but less regularity in width of lines. Lines cloudy and ill-defined, *not* seedy or frazzled, but with slight, rounded, flowing indentations, with tendency to air holes in surface of marks. Contours variable and irregular, but same key-type gives close general character to different impressions. No soiling of outer field by colored marks.

(Handwriting)—Cloudy, ill-defined line, resembling original in character, but serrations coarser, fewer, and less angular; (serrations more and finer than in copy of typewriting); numbers relatively regular and sides inclined to consistency with each other, but less constant than in two-point original handwriting.

2. *Stencil machines* (Regular style typewriting)—

(a) Duplicator.—Non-flowing mark, rougher than pad duplicating and pad typewriting; more irregular in size than latter; fewer serrations, and more exaggerated indentations, than ribbon typewriting. Sides show irregular opposed humps, few mushrooms, and many hammer heads. Edges very deep-cut, but not frazzled or seedy; cloudy and ill-defined, sometimes with corona. No soiling of outer field. Different cuts of same key-

type vary in width and character of line, but about same in serration numbers.

(b) Duplicator.—Less regular outline and size, and more prominent indentations than pad typewriting; less cut up than ribbon work. Edges cloudy and ill-defined, but have no corona, shoots or mushrooms; no frazzling, or opposed swellings—the humps being accidental in size and location. Excess of roughness shifts from side to side in different cuts of same key-type. More regular size and contour than (a) in such different cuts; no relation in serrations, between sides in such different cuts. *Otherwise,* serration number, range, and character of mark resemble (a).

(c) Duplicator.—Character, size, shape (but not outline) fairly regular. Line-swell irregular and unsymmetric, indentations being less prominent than (a) and (b) and rarely having shoots or mushrooms; edges often frazzled and ill-defined, or with corona—more cut than pad typewriting or (a) or (b), but less than ribbon work. No relation between sides as to serrations, which are angular. Outer field not soiled.

(d) Duplicator.—Cuts from same key-type resemble in general size and shape, but not in general character or outline, of marks. No soiling. Lines cloudy and ill-defined, but not seedy; inclined to fibrous frazzle; irregular unrelated swellings, no shoots and few mushrooms; edges continuous. Serrations small, curved, variable, and unrelated, having more variety and less prominence than in (a), (b), and (c). Indentations less frazzled and more prominent than (c), more frazzled and less prominent than (b), and more frazzled than (a). More prominently cut up, with greater variations of character, than pad typewriting. Less prominently cut up and frazzled, less consistent in character, more regular in size and shape, and less opposed swelling, than ribbon typewriting.

(e) Addressor.—General character, size and shape of different cuts of same key-type, alike, though actual contours vary. Lines cloudy or broken, and ill-defined, without shoots, mushrooms or soiling. Indentations frequent, irregular and deep; swellings irregular and not related to each other, even on same side. No relation between serrations, except sides nearly alike in numbers. More cut and irregular than pad duplicating. Deeper cut, more regular, rounder heads, than (a). Closely

resembles (b) but more symmetric, and indentations less prominent. Fewer and less angular serrations and indentations, than (c). Fewer, more regular, and less angular, serrations, with less fraying and less variance in side numbers, than (d). Deeper cut, and less regular, (except less variance between sides in numbers and contour), than pad typewriting. More regular in size, outline, and serration numbers, but less cut and frayed, and angular, edges, than ribbon typewriting.

(f) Addressor.—General character of different cuts of same key-type and stencil, alike, though actual sizes and contours differ. Lines cloudy, seedy, and with broken edges; indentations very irregular and may be deep; some shoots and mushrooms; serrations deep, angular, and sides bearing no fixed relation to each other. More broken and frazzled than pad duplicating, or (a) or (b). More broken, shoots, cuts, irregularities, and side pockets, and serrations more variable as to sides, than (c). More broken, frayed, seedy, shoots, and sudden changes of contour than (d). Edges more continuous, with less angularity, frazzle and seediness, than (e). More cut, frazzled and variable, than pad typewriting. Less broken, frazzled, opposed humps, seediness, and mushrooms, and more cloudy and shoots, than ribbon typewriting.

(Pin-point typewriting.)

(g) Addressor.—Spots separate and with no positive geometrical form; cloudy, ill-defined, seedy, frazzled; vary greatly in same cut and impression of same key-type. Outlines wild, variable, much broken, with indentations, shoots, and mushrooms. Less defined, more irregular, deeper cut, more seedy, frazzled and shot than (j), (k), or (l).

(h) Addressor.—Spots inclined to run together, and more regular across line than lengthwise; they vary in size and shape (but not location) in different cuts of same key-type. Lines cloudy and ill-defined. Indentations less prominent, edges less deeply cut, seedy, frazzled, and wild, with fewer shoots and mushrooms, than (g). Larger and more regular serrations, but less well defined and deeply cut, than (k), and (l), and also less regular in *shape* and more regular in position, than (k).

(Handwriting.)

(j) Duplicator.—Rougher and slightly less regular than two-point handwriting, with ill-defined, frayed, edges, prominent in-

dentations, and very many serrations. Distinctive marking due to file bed-plate on which stencil cut. Contours vary in size, but not much in zigzag outlines, which are generally in unison though sometimes opposed. Sides equally affected. No mushrooms.

(k) Duplicator.—Some show separate blotches of ink, with many mushrooms; spacing and direction of file cuts plainly visible. Others have spots run together, with many (but unrelated) serrations, and plenty of mushrooms, but no shoots. Line well defined, but frayed, and with opposed swellings; width variable, but less so than (a), though more cut up.

(1) Duplicator.—Lines broken into irregular separate blotches, showing file faces and spacing. Edges sharp. Slightly less regular than first type of (k), but difficult to distinguish from same.

(Clean-cut perforations.)

(m) Addressor.—Actual sizes, general shapes, character of outline edges, nearly alike in impressions of cut by same key-punch, but actual and relative serration numbers differ; no relation between side serration numbers. No soiling of outer field. No frazzling, and edges generally well defined; rarely seedy, or mushrooms, or small shoots; roughness not extreme. Less deeply cut and irregular than all other stencil markers, stamps, pad duplicators, and ribbon writers, and about like pad writers in this. Width of impressions affected by thickness of stencil and pressure exerted on it.

(Generally.)

In all *stencil* work, variations of outlines are principally in *reduction* of a maximum width, while in other work differences are mostly in *extension* of a given minimum width.

3. *Loose type machines* (Printing direct).

(n) Duplicator.—Lines clear cut, alike in general size, shape and character, though actual outlines vary considerably. Surface full of air holes, sometimes containing spots. Shoots and mushrooms rare. Sides vary and (except for air holes) only slightly and spasmodically indented. Resembles pad typewriting, except more distinctly marked, less shoots and serrations, and less variance in general size.

(Printing through ribbon.)

(o) Duplicator.—General shapes and characters agree, but much variance in widths and outlines of lines. Lines clear cut

(unless ink be of certain colors); outlines deep cut, very irregular, tending to opposed humps; some mushrooms, but rarely shoots; sides differ much. Occasional soiling. Serrations have no relation as to sides. Different "set-ups" vary considerably. Lines more cut than in (n) or in pad typewriting; less deeply cut, less frazzled and seedy, fewer mushrooms, and less pronounced ribbon effect, than in ribbon adding, billing, or typewriting, machines.

(p) Duplicator.—Outlines inclined to be cloudy. Sides very deeply, and very irregularly, indented, quite wild, but few opposed humps; many mushrooms, but few shoots. Wide variations, and no relation, in serration numbers. General character agrees. No soiling. Cutting of lines more pronounced and erratic than (o). Less broken, frazzled, seedy, and ribbon marks, than in ribbon adding, billing, or typewriting machines.

(q) Duplicator.—Impressions of *same* type rather regular in size, shape and outline, but other *similar* types vary. Lines usually clear cut, varying greatly in width, with occasional mushroom or shoot; no frazzle or seediness. Sides irregular, tending to slight opposed swelling and narrowing—*unlike humps*. Serration numbers almost relatively fixed in same impression of similar type, but differ in different impressions of other types. Much soiling, but hardly any ribbon effect or mark. Character close in same "set-up" of type. Less cut up than (n) and (o) and action more regular in different impressions of same stroke. Nearer like pad typewriting, except more soiling and shooting and variation in width of stroke, and better definition of edges.

(r) Duplicator.—Work blurred and indistinct, tending to corona; often broken, like pin-point work, in electrotypes. Same section of *same* type almost alike in width and character of line, in different impressions; but *different* types vary in same impression. Tendency to pronounced opposed humps of irregular form and location, their numbers agreeing usually in contemporaneous work of the same machine. Outlines wild in electrotypes, with many mushrooms and shoots; less so in "print." Serrations variable and unrelated. Resembles (p) but deeper cut. More irregular and indistinct and less finely serrated than (o). Deeper cut, more variable in size, than (q) and lacks its soiling and definition. Lacks the soiling, frazzle, and seediness of ribbon typewriter, adding, and billing, machines. Less regular edges

and sizes, deeper cut, fewer shoots, than pad typewriters or cash registers.

(s) Addressor.—Lines cloudy, ill-defined, with corona; wide but not frazzled; cut deeply and irregularly, with little evidence of opposed humps. Different impressions of the same type close in general character; much variation in size and outline, in impressions of different type. Many mushrooms but no shoots. Serrations variable and unrelated. General resemblance to (t) though less soiling, and details differ.

4. *"Plate" machines* (with ribbon).

(t) Addressor.—General resemblance in general appearance of contemporary work. Lines cloudy, seedy (not frazzled) ill-defined and wide, often with corona. Extravagantly cut outlines with opposed humps, (especially where type face is flat); different impressions of same types vary greatly, as to character (especially where type face is *rounded*) and less so in size. Mushrooms, but few shoots, present. Serrations variable and unrelated in numbers. Excessive soiling of outer field.

(Without ribbon.)

(u) Addressor.—Lines cloudy, and poorly defined, but clearer than (s) and (t); wide, and usually more even, and less wild, than (e), (f), (g), (h), (m), (s), and (t); where cuts deep, they are narrow slits *inwards;* irregularities of outline all appear to run *inward*. No soiling, frazzle, shoots, or opposed humps, but some mushrooms. Sides differ from each other, and different impressions from different cuts by same key-punch, vary slightly in width and outline. General character of work from same plate, agrees; lines from same plate and key-punch have preponderance of serrations on same side in different impressions,—otherwise serrations are variable and unrelated in numbers. Resembles pad typewriter work, but has fewer shoots and *protruding* cuts. More cut up and irregular than pad type-wheel lever-operated work. When marked surface is *very rough,* the details are about same as foregoing, except that lines narrow, much rougher, and more variable, with tendency to irregular *protruding* humps that deeply cut the edges.

D.—LOOSE TYPE PRINTING.

1. *Direct.*

(Ordinary type)—Well defined, non-flowing lines; general outlines with unusually even sides, and agree in size, shape, pro-

portions and general contour, in different impressions of same line, when printed on similar surface. *Characters* of marks of different types also agree if printed on same paper. Side lines vary in actual details. Indentations few and slight; serrations prominent, variable and unrelated in numbers. Practically no mushrooms or shoots, and edges do not have "ruled" effect. Slightly more uniform, but rougher, than hand-cut steel die, and lines clearer. About as rough as machine-cut steel die, but has more sudden and prominent humps. Both of these dies have more ruled edges, and vary more in actual sizes, and points, corners, and angles. The printing is more uniform and regular, with better definition and less prominent cutting, than steel plate engraving and copper plate engraving, and sides more even than latter and not frazzled. More uniform regular and even, and less cut up, than lithograph, photo, or wood, engraving, with better definition than steel plate lithographing, and lacks the "slits" of wood engraving. Script type lines on smooth paper, are particularly smooth.

(Smooth faced typewriter style)—Lines very rough, with few prominent opposed humps, and no ribbon marks or soiling. Outlines unsymmetric and not well defined. Less frayed and cut up, impressions more even, fewer mushrooms, and lines less broken, than in ribbon typewriting.

(Cut-faced typewriter style)—Lines broken, many prominent indentations opposed to each other; *holes in same relative and symmetrical positions* over face of line, and in different similar types of same letter. More "holes," symmetrical and uniform, and less frazzle, mushrooms, and soiling of outer field, than in ribbon typewriting.

2. *Under cloth.*

Exceeding rough, ill-defined, lines, much granulated and soiled; where air holes appear, their *location will vary* in different types of same letter. More uniform, less frazzled and soiled, and ribbon threads less clear, than in ribbon typewriting. More soiled, and less tendency to corona, than (r) and (o), and less definition than (o). More soiled and uniform, and less definition, than (p). More regular, and distinct, and less corona, than (s) and (t).

(Embossed work)—About like ordinary type printing, but characters ***raised*** above level of paper surface.

E.—ENGRAVING.

1. *Wood.*

(Cameo cuts.)

(a)—Type forms, printed direct.—Non-flowing well defined lines, different impressions retaining general size, width, shape, and character, but varying in actual contours. Indentations many, but not prominent, cutting being both inward and outward; few and small shoots or mushrooms. Serrations prominent, and numbers varied and unrelated. More cut and irregular than steel die work; about like steel plate work, except better defined, and less outward, and more inward, cuts. More distinct and less frazzled than copper plate work. Less uniform than stone lithograph; better defined and less varied outlines than steel lithograph; deeper cut than photogravure.

(b)—Script forms, printed direct.—Substantially like (a) except deeper cut than stone lithographs, though about as uniform.

(c)—Old prints, direct.—About like (a) except general contours more even and less rough, with small *out* cuts and tendency to deep slits *inwards,* sometimes crossing the line.

(d)—Recent prints, direct.—About like (a) except contours more even and less rough. More serrated and spotted than ordinary photogravures.

(e)—Script forms, under cloth.—Frazzled and soiled like ribbon typewriting, but fewer mushrooms. Very irregular, with prominent (somewhat opposed) humps. Ribbon marks not as pronounced or regular as typewriting, or as (r) and (t), *ante.* No air holes or corona, like (n) and (o). Unlike photogravure which lacks frazzle and soiling.

(Intaglio cuts.)

Much affected by paper surface. Outline usually rather regular and even, in contour, without any "ruled" effect. Sides vary; indentations few, inconspicuous, irregular and variable; serrations many, variable and unrelated. Lines of same cut agree in character in same impression and sometimes have prominent transverse *slits* inward. More uniform, and less prominently cut up, than cameo wood cuts, but slit effect is like (c). Deeper cut and less uniform than hand-cut steel die; less uniform, and less prominent, sporadic projections, than machine-cut steel die; less "ruled" effect than either die. Without mushrooms, fewer

shoots, more regular, and better defined, than steel plate. Not frazzled, less cut, and better defined, than copper plate. Less cutting in, and more regular, than stone lithograph. Better defined, and smoother edges, than steel lithograph. Fewer serrations than photo-engraving of similar lines.

2. *Metal.*

(Steel die, hand-cut.)

Cuts by same person agree in general character of outline, and show rather constant relation between characters of edges, with regard to each other; in *different cuts,* the sizes, shapes, and proportions, will vary somewhat, but in different impressions of the same cut, these features (and the "character") will be in general agreement, although edges not actually alike. Lines well defined, with "lake" surface; *smoothest of all marks covered;* outlines unusually straight and even, most of spreading being outwards, but practically no mushrooms or shoots. Indentations few and slight; serrations vary and are unrelated; both vary slightly in cuts of same person, and much in cuts of different people. Lines smoother than most handwriting.

(Steel die, machine cut.)

Different cuts of same master-die vary slightly in width, and considerably in corners and points, the latter being less regular than hand-cut dies. Well defined lake surface, nearly as smooth as hand-cut die, but serrations more angular; few mushrooms and shoots, but more than hand cut. Lines *straighter* than hand-cut, and as if *ruled;* sides differing slightly and forming long slight wavers. Few and slight indentations; serrations vary and run outwards. No relation in *character* of outlines; same master-die may differ widely in cuts, while different dies may resemble each other in cuts.

(Steel plates, hand-cut.)

General character of work of same person on same plate, retained in different impressions; general shapes, and sizes, close in different impressions. Marks have lake surface, and fairly even general contours though less so than die stamping. Usually well defined edges, though sometimes (depending on paper) seedy, frazzled and ill-defined; shoots and mushrooms in latter class. Cutting mostly *out,* but sometimes *in.* Indentations few and slight (except in frazzled lines) and unrelated. Serrations

prominent, and vary in even same plate; no fixed relation as to sides, though general limits of numbers roughly personal to engraver. Sides vary in same impression, and in different impressions of same stroke, in details—even in widths—more than hand-cut dies; corners and points about like machine-cut dies; rougher than either, and no "ruled" edges. Rougher than ordinary type printing.

(Copper plates, hand-cut.)

General size, shape, ends, and corners (but not actual outlines) of same lines of same plate, agree in different impressions, but may differ from other similar lines therein. Lines have lake surface, with uneven general contour, and are seedy, frazzled and ill-defined. Sides badly cut (running *outwards*) and actually vary, though of same general type; no "ruled" effect; many mushrooms but very few shoots. Serrations many and prominent, but unrelated—*except* that different impressions of same line and plate will approximate in preponderance of serrations, and that cutting of same person on same plate will have general types of serrations and character of outlines, *throughout* the plate. Corners, points, &c., resemble hand-cut dies, in regularity of impression, but margins more irregularly and prominently cut, than any steel die or plate work.

F.—LITHOGRAPHING.

1. *Stone.*

General size, shape and width of lines, close in different impressions; corners and points, less so; general outlines and locations of indentations and swellings, still less so. Well-defined lines with lake surface; sides vary in different lines and impressions, and are not "ruled" or usually straight. *Character* of lines and impressions of same plate rather uniform, showing distinctive personality of the designer. Indentations irregular and not prominent; cutting *mostly* out, not deep, and tending to long, slight swellings of sides independent of each other. Serrations pronounced, but variable and unrelated; appearance more like two-point handwriting, but more regular in total serration numbers. Less straight edge, deeper cut and more uniform in coarse features than steel dies. Better defined, more uniform in coarse features, and about same cut and variable sides, compared with steel plates. More distinct, and more uniform in coarse

features, than copper plate, and also not frazzled. Less rough than single-point ink handwriting.

2. *Steel.*

Non-flowing lines, variable, irregularly, much—often deeply—cut (inwards and outwards) with usually seedy edges; no shoots, but some mushrooms; no "ruling." Contours very uneven, and vary as to sides. Indentations prominent, and often exaggerated. Serrations numerous, variable and seem accidental; but tendency for numbers on the two sides of different strokes on same plate to nearly agree, and to run fewer in some plates than others. Character variable, between different lines, in same impression, or of different plates. Deeper cut than two-point handwriting. Rougher and more variable (except as to serration side numbers) than steel die stamping or engraving. More variable (except as before) and more frazzled than copper plate. More variable (with same exception), lines less distinct, and indentations more prominent, than stone lithographing.

G.—PHOTO-ENGRAVING.

1. *Of handwriting.*

Form, size, and shape, of original writing retained, but not serration numbers; and the cutting is rarely angular. Lines well defined, with varying sides; not ruled; usually cut outwards. Indentations sporadic, not prominent or deep. Serration numbers variable and unrelated, and affected by paper surface. Character of lines approximately retained throughout same impression. "Copy plate" writing straighter and smoother than the rest, but less so than steel die; ordinary writing about like steel plate, except fewer deep cuts, and more variety in serrations and general character; *both* kinds of writing more uniform in outline than steel lithograph, and less so than stone lithograph, and more distinct, and less cut and frazzled, than copper plate.

2. *Of typewriting.*

No resemblance to original typewriting in character, except in general size, shape, and in having opposed humps. No soiling, frazzle, seediness, or deep cuts, and hardly any mushrooms. Sides, and actual sizes and details vary. Humps not sudden and narrow, but *wide* (like mere swellings). Separate impressions of same original type (now on one plate) show about same rela-

tive numbers of serrations per sides, and their *characters* similar, throughout the *plate* impression. Cutting lacks angularity, therein being like photogravure of handwriting.

3. *Of lithograph.*

Considerable difference in width, size, form and actual outline when made of similar original letters. Sides vary, but general style of edge about like other photogravure work. Indentations prominent, often deep, irregular, and in and out. Serrations few, irregular, variable and unrelated in numbers. Resembles photogravure of handwriting, except "copy plate," which is smoother. Less uniform, at times cut deeper, than stone lithograph, and more like steel lithograph.

H.—MISCELLANEOUS.

The foregoing classifications cover a large field in detail; to them may be added *brief* general references to several other sorts of marks.

1. *"Cerotype" plates:*—Such work, when analyzed, is found to give results between stone and steel lithographs.

2. *Electrotypes:*—The results obtained here are between steel die stamping and steel plate printing.

3. *"Screen" photogravures:*—The regular geometric spotted effects of this process are so individually distinctive as to require no comment.

4. *Additional addressor:*—The analysis here *approaches* to type-wheel, pad-inked, lever-operated work.

Several appliances have come out since the present tests were completed and are not herein specifically considered, though their general processes are covered.

CONCLUSIONS.

From what has been set forth it may be concluded:

1. In no purely mechanical process is there the same fixity of relations in serration *numbers* that exists in two-point handwriting.

2. The mechanical process most nearly approaching (generally) to such handwriting, is stone lithograph work.

3. The smoothest outline is produced by hand-cut steel die stamping.

4. The roughest marks are those made through a cloth or ribbon.

5. Photo-engraving reproduces in its mechanograms but few of the characteristics to be found in the originals thereof.

6. Where the actual marker is fashioned directly by human hands, its mechanograms will contain means of identifying those hands.

7. In some processes, where the mechanical appliance derives its operating power from human hands, the mechanograms will assist in the identification of the operator.

8. Every mechanical process produces a distinctive type of mechanogram.

9. Every individual marking appliance produces mechanograms containing characteristics individual to the particular appliance. Once discovered, they will identify and differentiate the appliance.

10. "Ancient" documents, of *modern* manufacture, and all sorts of imitations and "facsimiles" may be detected by means of their mechanograms.

WEBSTER A. MELCHER,
The Marksman.

Philadelphia, Pa.
January 15, 1914.